

The Ebola Viral Disease – Changed Outbreak In A Changing World

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ABSTRACT: The recent outbreak of Ebola viral disease in West Africa was the largest Ebola epidemic ever recorded in human history. Thousands of people lost their life or families, three entire countries – Guinea, Sierra Leone and Liberia – were totally devastated and their economics and health systems will need decades to restore to normal function. The current review tries to summarize the novel elements in the West Africa Ebola outbreak and to identify the reasons for the sudden virus attack in a totally unexpected region. Non-medical and non-epidemiological reasons are the most cited – for the first time in our history a viral outbreak is directly linked with the global climate change. Among the other arguments in the origin of the West Africa Ebola outbreak we should outline the economic situation in the affected countries, the late international response and the absence of correspondence between the local communities and the health authorities. Now, when recapitulation of the last two years is going, we need to provide the correct answers of why and how this outbreak happened. It's time to give a new meaning of human nature-deteriorating activities threatening in many cases our own health and well-being.

KEYWORDS: Ebola virus, Ebola viral disease, Hemorrhagic Fever, Climate change, Africa, Western.

1. INTRODUCTION

In March 2014, the following message appeared in the section *Disease outbreak news* on the web-site of WHO (World Health Organization): „The Ministry of Health (MoH) of Guinea has notified WHO of a rapidly evolving outbreak of Ebola virus disease (EVD) in forested areas of south-eastern Guinea. As of 22 March 2014, a total of 49 cases including 29 deaths (case fatality ratio: 59%) had been reported.“ [1]. Guinea has declared the first Ebola outbreak in its history – a viral disease, barely known in this part of Africa. Two years later (14.01.2016) the end of the West Africa outbreak has been declared with the interruption of Liberia's Ebola transmission chain – a neighbor country which had joined Guinea and Sierra Leone in the worst epidemical scenario ever experienced from the mankind. Several hours after the WHO press release on Ebola epidemic's end, a new case was registered in Sierra Leone showing that the nightmare is still going with residual flare-ups of the disease [2].

For a period of two years EVD has killed more than 11316 people and infected 28638 (as of 17 January 2016) – impressive figures but when compared with the burden of other infectious diseases (for example the annual share of malaria for 2015 was 214 million cases and 438 000 deaths) [3], they seem almost negligible. Thus, why the 2014-2015 Ebola outbreak has attracted so much attention and has generated unprecedented media interest? Never before in the human history has an outbreak resonated at such degree. Besides the fact, that the disease is a severe, hemorrhagic fever, caused by a highly transmissible and deadly virus, this time it has attacked a totally unpredictable geographic area and target population. The recent outbreak took place in West Africa – a very poor and unstable region without operating health system, border control and infrastructure, but which is not considered endemic for the disease. In addition, that particular Ebola virus has targeted dense, urban communities with intensive traffic and international exchange. In other words, the virus has extended its areal and achieved to surprise the unsuspecting health and governmental authorities in the affected countries. Or, as WHO declared in one of its press release „never before in recorded history has a biosafety level four pathogen infected so many people so quickly, over such a broad geographical area, for so long“[4]. The exportation of the disease out of West Africa was a matter of time and nobody was sure if we could succeed to manage an almost unknown infection with no treatment or prevention. In this context, the most important factor for the total Ebola panic was our ignorance of EVD – until recently the virus has represented just an example of rare viral hemorrhagic fever in the books of virology and even experts were unfamiliar to recognize EVD and to work with potentially infected patients.

Beyond the terrifying aspects of EVD, the 2014-2015 outbreak exemplifies the actual situation in the global public health and the need of new strategies and multidisciplinary approaches to prevent emerging health crises becoming humanitarian disasters. For the first time, WHO target and regional policy was questioning and widely discussed. The conservative and time-consuming scientific process for production of effective antiviral drugs and vaccines was also questioning and during the last year we witnessed an implementation of altered protocol for vaccine introduction. But the most important still remains to be done – the total change in our perception of the link between human health, animal health, natural resources, ecology, and sustained local economics.

2. BRIEF HISTORY OF EBOLA OUTBREAKS

The Ebola virus was first identified in 1976 [5], [6], [7] in two simultaneous outbreaks: the first one in Nzara (South Sudan) in month of June 1976, where 151 people lost their life; and the second one in Yambuku, a village near the Ebola River (northern Democratic Republic of the Congo (previously Zaire) in August 1976, with a total of 318 cases and 280 deaths. The outbreak in Yambuku was very well documented with identified index case (patient zero), who was initially diagnosed with malaria and treated with quinine injection in a local mission hospital. Shortly many new cases spread in the hospital (including the staff) mainly due to the insufficient hygiene and poor sterilization of used devices. This outbreak gained the attention of international health and scientific community and lead to the isolation of Ebola virus, which was taxonomically placed in family *Filoviridae*, genus *Ebolavirus*. Subsequently, five species of Ebolaviruses were recognized in different outbreaks: *Zaire*, *Bundibugyo*, *Sudan*, *Reston* and *Tai Forest* [8].

Between 1976 and 2013, WHO reported a total of 24 outbreaks involving 1716 human cases in Sub-Saharan Africa (Democratic Republic of Congo, Sudan, Gabon, Uganda, Republic of the Congo, Côte d'Ivoire), several laboratory contaminations all around the world and cases in a monkey export facility in the Philippines [9].

Since 70s, the disease has been largely ignored by the international health community and has not been considered a real public health problem. Ebola was regarded as a potentially dangerous but exotic disease occurring somewhere in the “dark continent”. This perception was facilitated by the fact, that previous outbreaks were registered in isolated forest regions with almost no population transfer and communication, thus easy to be limited and overcome. The current outbreak, in contrast, involved large urbanized regions in three entire countries (Guinea, Sierra Leone and Liberia) devastated by years of civil wars and habituated to vast human circulation. In addition, the health authorities and medical workers in countries previously reported to be endemic for Ebola have experienced outbreaks for long time and were well prepared for them – an example of this is the occurrence of simultaneous (August-November 2014) and unrelated to the West African outbreak in Democratic Republic of the Congo, where morbidity was limited to 66 human cases and 49 deaths [9]. West African countries, which had never encountered an Ebola outbreak, were not prepared and several long months from the beginning of the epidemics they didn't realize what happen in their territories.

3. TRANSMISSION OF EVD

Although no confirmed evidence exists, fruit bats of the family *Pteropodidae* (genera *Hypsignathus*, *Epomops*, and *Myonycteris*) are considered as natural reservoirs of Ebola viruses [8]. Humans and monkeys are not regarded as reservoir species because of the high mortality, but as end-hosts. We still don't know how bats transmit the virus to humans or apes – possible ways are direct contact of person's injured skin or mucosa with animal fluids during butchering or collection of already contaminated plants for food. Monkeys can also serve as spill-over species to transmit the virus from bats to human.

In most of the Ebola outbreaks the sequence of events follows similar pathway: high disease prevalence and mortality among wild animals, especially apes in a given area [10]; then the infected animal is hunted for food or its carcass is found by a villager; persons of initial contact become ill and the infection is spread to the close family, community members and medical staff carrying about them. Person-to-person transmission occurs through direct contact with body fluids of the infected individual (blood, secretions, vomiting materials, feces and semen) or via contact with surfaces and materials contaminated with these fluids. Finally and specifically important for the 2014-2015 outbreak, infection is transmitted to the people taking part in rituals (including touching, kissing, washing of dead body) during traditional burial ceremonies of the victims.

To date, only one evidence exists for sexual transmission of the virus – in March 2015, a woman from Monrovia, Liberia tested positive for Ebola after having unprotected sexual contact with a EVD survivor, whose semen showed persistence of intact Ebola virus 199 days after his recovery [11]. Thus, possible sexual transmission cannot be excluded and WHO considers that it is of importance for future flare-ups of the disease [12].

4. EPIDEMIOLOGY OF THE CURRENT OUTBREAK

The conquering march of Ebola virus through population of West Africa began in the small village of Meliandou with the first infected patient – a 2-year-old child, who died after a mysterious infection in December 2013 [13].

Only one (not fatal) Ebola case was ever registered in this part of Africa – in 1994 a scientist became infected after handling a dead wild chimpanzee in the Taï Forest, Côte d'Ivoire [14]. Surprisingly, the virus causing the 2014-2015 West African outbreak didn't belong to Taï Forest Ebola subtype but to the elongated and unfortunately more deadly Zaire subtype. For the first time the virus was found far away from the previously reported habitat in entirely novel region.

The most likely transmission route included possible contact between the child and a wild animal (bat). Soon other family and community members of the index case followed and spread the infection to other neighbor villages. Because of lack of diagnostic experience, the emerged strange disease received its proper diagnosis after three long months in March 2014 when a significant number of individuals were already infected. The epidemic situation soon became worse, as the outbreak epicenter was concentrated near the borders with two other African countries – Sierra Leone and Liberia. In this region, borders are extremely porous as a result of years of civil wars and people migrate according the availability of resources. In addition, the border region of Guinea, Liberia and Sierra Leone is inhabited by the same ethnic group, thus the free movement of infected people was facilitated. Even at the time when simultaneous transmission chains were well present in the three affected countries the outbreak was considered an African problem with no real international significance.

Eight long months after the beginning of the outbreak and continuous multiplication of cases, WHO finally decided to declare a public health emergency of international concern. This decision followed the first air traveler transmission to country out of Western Africa and the infection of hundreds of health workers. At this point, the international community started to act and WHO together with other international partners took finally its role in the crisis. In approximately one year and after many foreseen and unexpected troubles, the outbreak has been successfully managed – dozens of medical centers were constructed, people were trained and financial and logistic support (although insufficient) was provided. More than 40 organizations and 58 foreign medical teams with 2500 health workers have taken part in the control of the Ebola outbreak; more than 60 specialized Ebola treatment units and 63 Ebola community care centers with 3000 beds were established for care of infected patients [15].

The epidemic was limited to West Africa, because all other cases arose after the international emergency declaration and out-of-region transmission chains were interrupted at time. Seven additional countries had reported Ebola cases – US, Spain, Italy, UK, Senegal, Nigeria, and Mali. The later three although with weak health systems and economics succeeded to manage all imported cases because of a high level of alert and preparedness: the firsts cases were recognized immediately and treated as a national emergency.

5. WHY IT HAPPENED? – REASONS FOR THE WEST AFRICA EBOLA OUTBREAK

The clinical manifestation, duration and case fatality rate in West Africa Ebola outbreak were similar to those in earlier epidemics. But it is clear, that the 2014-2015 West Africa Ebola outbreak was different – the virus showed changed epidemiology – new geographic area was conquered and other population was targeted. Now, when we need to analyze and understand what happened, the most important question is to determine the reasons for this outbreak. Non-medical and non-epidemiological reasons are the most cited regarding the West Africa Ebola outbreak – for the first time in our history a viral outbreak is directly linked with the global climate change [16], [17], [18], [19]. Among the other arguments in the origin of the West Africa Ebola outbreak we should outline the economic situation in the affected countries and the absence of correspondence between the local communities and the health authorities.

5.1. Climate Change And Deforestation – The Major Responsible

Usually, Ebola outbreaks happen during the transition period from the rainy to dry season [18]. Meteorological satellite data, exploring the time of past outbreaks, showed sudden climate changes – considerably drier conditions at the end of the rainy season – to be associated with the Ebola outbreaks [18], [19]. Indeed, all villagers in the initial region of West Africa outbreak reported an extreme dryness at the end of the rainy season before the epidemic start [16]. But a short-term climate change can be only the trigger of such devastating and vast outbreak, additional long-lasting factors responsible for the changed attitude of the virus must exist. The big question of why the virus suddenly emerged from the forest of West Africa is still unanswered. Was it present there for many years, but hidden in the forest? This is a possible scenario, which involves contact of an individual with infected animal as the size of forest habitats has been extremely decreasing – last decades West Africa was a scene of profound timber and mining operations. Reduction of forest natural size put human in close contact

with potentially infected wild animals, especially when this happens in poor and instable regions with starved population progressively seeking bush meat as protein source. The agriculture in the region was considerably changed from subsistence farming to industrialized farming of oil palm and in this way it is very likely that the bats changed their natural forest habitat with the oil palm plantations, thus increasing the chance of contact with humans.

Transfer of the disease from Central to West Africa is also a possibility, especially when considering typing of the virus as *Zaire* subtype and not as the neighbor *Tai Forest* subtype. Human transmission is less hypothetical as it takes much time to cross the distance of thousands of kilometers with almost no roads. Bat or other wild animal transmission is more likely, but this also put new ecological questions of how and why a wild species modifies its behavior [16]. If this was the true scenario, then the absence of cases in the territories between Central and West Africa cannot be easily explained.

5.2. Local Economics And Health Systems

Guinea, Sierra Leone and Liberia are among the poorest countries in the world. They are placed at positions 148, 154 and 167 of 193 countries in the World Bank ranking according to gross domestic product accumulation; at positions 159, 178 and 180 of 189 – according to electricity access [20]. In all of them more than 50% of the population is living below the national poverty line. Years of civil war, coups d'état and unstable political situation left a community of almost illiterate and impoverished people. National roads, telecommunication services and border control in the affected region are weak and unsafe.

The three affected countries are composed of dozens of different ethnic groups with different religion, language and customs. Sierra Leone is an ex-British colony that suffered of 10-years-long civil war (1991-2002) with an inadequate health system and approximately two physicians per 100,000 population in 2010 [21]. Guinea is an ex-French colony with an existing but fragile health system and approximately one physician per 100,000 population in 2005 [21]. Liberia initially settled as a free state of liberated African Americans had experienced two consecutive civil wars (1989-2003) and also has one available doctor per 100,000 population [21]. Surprisingly, the past colonial or settling history has shown to be of great negative importance for the outbreak management – the financial support was divided according to political interests and was not equal among the affected countries – although most affected Guinea (the only francophone country among the three) received the least from international aid [22]. Even at this moment the information present at the official British and French governmental sites concerns only activities in Sierra Leone or Guinea respectively.

Hospitals in the affected region (if any) even before the outbreak had experienced basic equipment shortage and insufficient number of doctors and nurses. Soon after the beginning of the Ebola crisis the weak health systems of the involved countries totally collapsed with no ability to fight against the virus. A significant number of health workers (850) have been affected during the outbreak, half of them lost their life and the already pre-existing shortages in medical care professionals was exacerbated.

This fragile health system has been combined with existing poor hospital hygiene practices and infection control measures, which facilitated the disease transmission.

The health authorities in their powerlessness decided to apply ineffective and controversial measures – restrictions on movement of persons, setting up of sanitary barriers, unnecessary quarantines – the complete fear reigned not only in the region but in the entire world. These extreme measures were also applied by other governments – some US states forced mandatory 21-day quarantines to American nurses and doctors returning from West Africa although no symptoms were present and hence no transmission can occur (EVD is contagious after symptoms appearance and not during the incubation period).

5.3. Urbanization And Better Connectivity

Some reports suggest that the total population living in the region directly menaced from Ebola has nearly tripled (from 230 million to 639 million) and the urban population has increased from 25.5% to 59.2% [23], [24]. The capitals and large cities represent an ideal environment for any epidemic agent. Previous Ebola outbreaks took place in isolated, small villages. The 2014-2015 outbreak is concentrated in urban areas where transmission chains could not be easily tracked and contacts could not be identified. In addition, after the civil wars in Liberia and Sierra Leone, a number of refugees have crossed the borders, boosting the size of poor and untraceable population. Traditionally, African population is very mobile [23] with a high degree of relatives in different villages and even countries. In addition, poverty pushes people to move often illegally looking for water, food or better work and spreading the disease indefinitely.

For the last decades, African population has also become better connected internationally [24]. One of the biggest fears in this outbreak – the exportation of Ebola virus from the affected region – occurred in July 2014. An infected man arrived at the airport of Lagos, Nigeria; two months later another one landed in Texas, USA. All countries in the world were at risk; all

people travelling around the world were at risk. Although considered at very low risk, Bulgaria has also experienced a scenario of possible Ebola infection: a 57-year-old man had returned few weeks ago from Sierra-Leone presented with Ebola-like symptoms in November 2014; it was diagnosed finally as malaria, but the enclosed demon of fear was released and the media coverage of the case was spectacular.

5.4. Lack of population understanding and poor compliance of the population with health instructions

Local inhabitants didn't understand the nature of this viral epidemic or they simply refused to understand something contrasting to their ancient cultural beliefs and practices. Some of them even refused to believe in the real existence of Ebola, preferring to trust alternative explanations or conspirative theories. Medical authorities and international specialists didn't succeed to find a common language with the poorly educated (according to the Western standards) people. For treatment, local population preferred to rely on traditional healers and herbalists. After the crisis began, the hospitals soon turned to be places of death in the imagination of the inhabitants and people logically chose the option, they were familiar with.

Unfortunately, the Ebola epidemiology was consistent with some high-risk behaviors of the local population, especially in their burial rites which included a close exposure to the infected body. WHO estimated that 60% of cases in Guinea and 80% in Sierra Leone could be linked to traditional burial and funeral practices [25]. Burial rites in Africa are often covered with mystery and occultism consisting of numerous secret practices, which often assemble dozens of relatives around the dead body. International partners put a lot of efforts to securize funerals but these efforts met the community resistance, as in many cases were performed by armed forces without respecting rites. Local population logically was afraid of strangely-dressed and equipped foreigners in their villages who put restrictions and hospitalized their relatives; and villagers answered with mistrust and aggression. In August 2014, armed people attacked an Ebola clinic in Liberia, released the patients and stole contaminated hospital equipment. In September 2014, eight persons including health workers and journalists who were disseminating information about Ebola were killed by villagers. Several days later, Red Cross volunteers in Guinea were assaulted while collecting a dead body in a community.

Health messages from national and international authorities had adverse effect in affected villages – instead of achieving better information and protection of population, they stressed on disease fatality and community predestination. EVD is a contact disease and is strongly related to people communication in close family and community. Engaged international bodies had to turn from a neutral social and professional activity to more community-orientated behavior, giving clear and comprehensive messages able to convince local inhabitants.

6. LESSONS FROM THE OUTBREAK – NEW APPROACHES IN ACTION

To manage a serious epidemic danger we need cooperative activity of professionals from different fields of expertise – public health specialists alone cannot provide an appropriate response to the challenge. The 2014-2015 West Africa Ebola outbreak demonstrated to a great extent the need of closer relationship: (1) between human and veterinary medicine and (2) between medicine and other science. In the pre-epidemic stages, the role of animal health specialists is very important. Ebola outbreaks in wild animals often precede human cases and it is important to watch for unexplained deaths among corresponding animals implicated in the virus transmission [26] – in regions where epidemic threat exists there is a need of well-functioning wild animal monitoring. The animal mortality surveillance can serve as a warning system for local health authorities, as such an example exists in Gabon and Republic of Congo [27], where Ebola outbreaks were successfully predicted twice.

Anthropologists can help in different situations, especially at the phase of rigorous outbreak response, when urgent measures need to be taken but in the way they are acceptable by the local people. It is vital, anthropologists to take part in the epidemiological investigations, patient contact and community mobilization. One of the main lessons from the current Ebola outbreak is to listen to the local community demands, to respect their beliefs and cultural customs. Anthropology and sociology can serve as a translation tool between the pure and often incomprehensible science and people's indigenous knowledge. In this way the severe episodes of hostility and violence against medical staff and international experts, we witnessed two years ago, could be avoided. Introducing bans, such as a ban on travel, hunting or traditional funerals are not effective and not natural in remote, impoverished and starving areas. People must be treated as human beings, not as victims and cases.

The 2014-2015 West Africa Ebola outbreak was one of the first times to use alternative information sources, especially big digital data management to characterize epidemiological patterns of an infectious disease. The most significant example in this context was the tool HealthMap, the Internet global leader in utilizing online informal sources for disease outbreak monitoring and surveillance of emerging public health threats, which has achieved to predict the outbreak 10 days before the

official WHO announcement [28]. In other study, a systematic collection of Internet news reports during the outbreak was used [29] to gather information on patient exposure, contact patterns, and discharge status – the findings were consistent with the traditional epidemiological surveillance data – namely the major transmission routes were found to be family members contact, hospital care and exposure during funerals. Another team has used Google Trends to assess all Google searches for “Ebola” between January 2014 and October 2014 and found the search frequency in affected countries to highly correlate with the epidemic curves.

The recent EVD crisis also achieved to reform our perception for new drug development protocols. As precedent Ebola outbreaks were sporadic, treatment or vaccine didn’t exist at the time of the 2014-2015 outbreak. Research efforts had led to the development of potential drugs and vaccines against EVD, but none of them had completed clinical trials in humans as at 2014, regarded as unsound investment from most of the health-care companies. The rapid and violent attack of the virus however changed this view but there was no time to fulfil all rigorous requirements for human testing. In August 2014, after long consultations WHO approved under the particular circumstances of this outbreak the potential use of unregistered drugs, vaccines and passive immunotherapeutic. This is not an exception – in 2002, after a series of anthrax attacks, the US Food and Drug Administration approved the Animal Rule, which permits the approval of some products based on safety testing in humans and efficacy testing in animals.

As a result, in August 2015, after implication of a novel cluster-randomized trial design, a recombinant, replication-competent vesicular stomatitis virus-based vaccine (rVSV-ZEBOV) was found to be 100% efficient in humans – this gave the first flash of hope and showed that when combining international efforts at different levels it could be possible to fight emerging diseases.

7. CONCLUSIONS

The cruel Ebola outbreak in Western Africa showed that we were not ready to face an epidemic of such extent. Managing future infectious threats requires not only urgent measures for preparedness and local economic stability but most importantly an urgent change in our perception of human-environment interaction and limitation of our nature- (and hence self-) destroying activities.

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